

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

Claims 1-13. (canceled).

14. (new) An electric-discharge machining apparatus for controlling a machining axis so that a machining average voltage V_g during a predetermined sampling time T_s agrees with a servo standard voltage SV , the apparatus comprising:

an electric power supplier for supplying electric power between electrodes of a tool electrode and a target to be machined;

an electric-discharge detection circuit for detecting the waveform of electric discharge generating between the electrodes based on the electric power supplied by the electric power supplier;

an electric-discharge generation counter for counting in response to the waveform an electric-discharge generation count N_d during the predetermined sampling time T_s ;

a calculator for calculating an estimation average voltage V_{gs} between the electrodes, based on:

$$V_{gs} = V_0 - \frac{N_d}{T_s} \times \{T_{on} \times (V_0 - e_g) + T_{off} \times V_0\}$$

where N_d is the electric-discharge generation count, V_0 is a predetermined applied voltage, T_{on} is a pulse width, T_{off} is a rest time, e_g is an electric-discharge voltage, and T_s is the sampling time; and

an electrode-position controller for controlling the machining axis so that the estimation average voltage V_{gs} calculated by the calculator agrees with the servo standard voltage SV during the sampling time T_s .

15. (new) An electric-discharge machining apparatus as recited in claim 14, further comprising:

in addition to the electric-discharge generation counter, a short-circuit generation counter for counting a short-circuit count $N1$ of short-circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by the electric power supplier is lower than a predetermined short-circuit threshold voltage V_{sh} , wherein calculation of the estimation average voltage V_{gs} by the calculator is compensated.

16. (new). An electric-discharge machining apparatus as recited in claim 15, wherein the estimation average voltage V_{gs} is calculated by:

$$V_{gs} = V_0 - \frac{Nd - N1}{T_s} \{Ton(V_0 - eg) + Toff \times V_0\} - \frac{N1}{T_s} \{V_0 \times (Ton + Toff)\}$$

17. (new) An electric-discharge machining apparatus for controlling a machining axis so that a machining average voltage V_g during a predetermined sampling time T_s agrees with a servo standard voltage SV , the apparatus comprising:

an electric power supplier for supplying electric power between electrodes of a tool electrode and a target to be machined;

an electric-discharge detection circuit for detecting the waveform of electric discharge generating between the electrodes based on the electric power supplied by the electric power supplier;

an electric-discharge generation counter for counting in response to the waveform an electric-discharge generation count Nd during the predetermined sampling time Ts;

a short-circuit generation counter for counting a short-circuit count N1 of short-circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by the electric power supplier is lower than a predetermined short-circuit threshold voltage Vsh;

a small unloading electric-discharge counter for counting a small unloading electric-discharge count N2 of electric discharge to which the applied voltage supplied by the electric power supplier changes within a predetermined small unloading time Tdo;

a calculator for calculating an estimation average voltage Vgs between the electrodes, based on the electric-discharge generation count Nd, the short-circuit count N1, the small unloading electric-discharge count N2, and the abnormal electric-discharge count N3; and

an electrode-position controller for controlling the machining axis so that the estimation average voltage Vgs calculated by the calculator agrees with the servo standard voltage SV during the sampling time Ts.

18. (new) An electric-discharge machining apparatus as recited in claim 17, wherein the estimation average voltage Vgs is calculated considering rest-time extension based on the electric-discharge generation other than normal electric-discharge generation.

19. (new) An electric-discharge machining apparatus as recited in claim 18, wherein the estimation average voltage Vgs is calculated by:

$$Vgs = V0 - \frac{Nd - N1}{Ts} \{T_{or}(V0 - eg) + T_{off} \times V0\}$$

$$-\frac{N1}{Ts}\{V0(Ton + Toff)\} - \frac{1}{Ts}\{V0(N1 \times Toffs1 + N2 \times Toffs2 + N3 \times Toffs3)\}$$

where Toffs1 is a rest time according to the short circuit, Toffs2 is a rest time according to the small unloading electric discharge, and Toffs3 is a rest time according to the abnormal electric discharge.

20. (new) An electric-discharge machining apparatus for controlling a machining axis so that a machining average voltage V_g during a predetermined sampling time T_s agrees with a servo standard voltage SV , the apparatus comprising:

an electric power supplier for supplying electric power between electrodes of a tool electrode and a target to be machined;

an electric-discharge detection circuit for detecting the waveform of electric discharge generating between the electrodes based on the electric power supplied by the electric power supplier;

an electric-discharge generation counter for counting in response to the waveform an electric-discharge generation count N_d during the predetermined sampling time T_s ;

a small unloading electric-discharge counter for counting a small unloading electric-discharge count N_2 of electric discharge to which electric discharge accompanied by the applied voltage supplied by the electric power supplier changes within a predetermined small unloading time T_{do} ;

a calculator for calculating an estimation average voltage V_{gs} between the electrodes, based on the electric-discharge generation count N_d , and the small unloading electric-discharge count N_2 ; and

an electrode-position controller for controlling the machining axis so that the estimation average voltage V_{gs} calculated by the calculator agrees with the servo standard voltage SV during the sampling time T_s .

21. (new) An electric-discharge machining apparatus as recited in claim 20, wherein the small unloading time T_{do} is set to 0.3 - 0.5 times a limited unloading time T_{ds} calculated based on the average current density I_d of the electric discharge.

22. (new) An electric-discharge machining method of controlling a machining axis so that a machining average voltage V_g during a predetermined sampling time T_s agrees with a servo standard voltage SV , the method comprising:

a step of detecting the waveform of electric discharge generating, based on supplied electric power, between electrodes of a tool electrode and a target to be machined;

a step of counting in response to the waveform an electric-discharge generation count N_d during the predetermined sampling time T_s ;

a step of calculating an estimation average voltage V_{gs} between the electrodes, based on the electric-discharge generation count N_d , and based on:

$$V_{gs} = V_0 - \frac{N_d}{T_s} \times \{T_{on} \times (V_0 - e_g) + T_{off} \times V_0\}$$

where V_0 is a predetermined applied voltage, T_{on} is a pulse width, T_{off} is a rest time, e_g is an electric-discharge voltage, and T_s is the sampling time; and

a step of controlling the machining axis so that the estimation average voltage V_{gs} calculated agrees with the servo standard voltage SV within the sampling time T_s .

23. (new) An electric-discharge machining method as recited in claim 22, wherein the estimation average voltage V_{gs} is obtained by counting a short-circuit count N_1 of short-

circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by an electric power supplier is lower than a predetermined short-circuit threshold voltage V_{sh} , and by compensating using:

$$V_{gs} = V_0 - \frac{Nd - N1}{Ts} \{Ton(V_0 - eg) + Toff \times V_0\} - \frac{N1}{Ts} \{V_0 \times (Ton + Toff)\}$$

24. (new) An electric-discharge machining method as recited in claim 22, wherein the estimation average voltage V_{gs} is obtained by counting a short-circuit count $N1$ of short-circuit electric discharge in which the voltage of electric discharge accompanied by the applied voltage supplied by an electric power supplier is lower than a predetermined short-circuit threshold voltage V_{sh} , a small unloading electric-discharge count $N2$ of electric discharge to which the applied voltage supplied by the electric power supplier changes within a predetermined small unloading time T_{do} , and an abnormal electric-discharge count $N3$ of abnormal electric discharge whose voltage reaches a lower value than a predetermined abnormal electric-discharge threshold voltage V_{ng} , and by using:

$$V_{gs} = V_0 - \frac{Nd - N1}{Ts} \{Ton(V_0 - eg) + Toff \times V_0\} - \frac{N1}{Ts} \{V_0(Ton + Toff)\} - \frac{1}{Ts} \{V_0(N1 \times Toffs1 + N2 \times Toffs2 + N3 \times Toffs3)\}$$

where $Toffs1$ is a rest time according to the short circuit, $Toffs2$ is a rest time according to the small unloading electric discharge, and $Toffs3$ is a rest time according to the abnormal electric discharge.

25. (new) An electric-discharge machining method of controlling a machining axis so that a machining average voltage V_g during a predetermined sampling time T_s agrees with a servo standard voltage SV , the method comprising:

a step of detecting the waveform of electric discharge generating, based on supplied electric power, between electrodes of a tool electrode and a target to be machined;

a step of counting in response to the waveform an electric-discharge generation count N_d during the predetermined sampling time T_s ;

a step of counting a small unloading electric-discharge count N_2 of electric discharge to which electric discharge accompanied by the applied voltage supplied by an electric power supplier changes within a predetermined small unloading time T_{do} ,

a step of calculating an estimation average voltage V_{gs} between the electrodes, based on the electric-discharge counts N_d , and N_2 ; and

a step of controlling the machining axis so that the estimation average voltage V_{gs} calculated agrees with the servo standard voltage S_V during the sampling time T_s .